

SPECIFICATIONS FOR PIPELINE OCCUPANCY
OF
SEDA-COG JOINT RAIL AUTHORITY PROPERTY

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Section 1.0 GENERAL

1.1 Scope

- A. These specifications shall apply to the design and construction of pipelines carrying flammable or non-flammable substances as well as casings containing wires, cables, and carrier pipes across and along SEDA-COG Joint Rail Authority (JRA) property and facilities.
- B. These specifications shall also apply to tracks owned by third parties (sidings, industry tracks, etc.), over which the JRA, or its contract operator, operates any equipment.
- C. All interested parties understand and acknowledge the JRA owns its right-of-way for the primary purpose of operating a railroad, in furtherance of its public mission of industrial and economic development. All occupancies shall therefore be designed and constructed so that rail operations and facilities are not interfered with, interrupted or endangered and that unreasonable dangers are not posed to persons or property. In addition, the proposed facility shall be located to minimize encumbrance to the right-of-way so that the JRA will have unrestricted use of the railroad and associated property for current and future operations.

1.2 Definitions

JRA	SEDA-COG Joint Rail Authority
Property Manager	JRA's designated Property Manager or his designated representative
Engineer	JRA's designated Engineer or his designated representative
Applicant	Any individual person, corporation (or other private entity recognized as having a legal existence), or government agency who applies to occupy any portion of JRA Property
Owner	The owner of a utility or facility which occupies JRA property or which has been approved for such occupancy
Professional Engineer	Person licensed as a professional engineer in the state where the facilities are to be constructed
Carrier Pipe	Pipe used to transport the product
Casing Pipe	Pipe through which the carrier pipe is installed, under the tracks, which should be adequate for the protection of the enclosed carrier pipe, consistent with the criteria set forth in these specifications
Sidings or Industry Tracks	Tracks located off of JRA's right-of-way, serving an industry

1.3 Application for Occupancy

- A. By applying for a permit to occupy any JRA property with pipelines, the Applicant agrees to the following: (1) No occupation shall be permitted without pre-approval of all engineering and construction details by the Property Manager or Engineer for occupation of JRA property; (2) Applicant shall execute an appropriate JRA agreement as prepared by the Property Manager; and (3) Applicant shall pay any required fees /or rentals specified herein.
- B. Occupancy applications shall be completed in full with all of the required information requested in order for the application to be processed. It is preferred that all application materials be submitted via email to the Property Manager. If this is not possible the application letter shall be addressed to the Property Manager, SEDA-COG Joint Rail Authority, 201 Furnace Road, Lewisburg, PA 17837. Please contact the JRA Property Manager at 570-524-4491 for current email address.
- C. The application cover letter shall include at a minimum the following:
 - 1. Legal name of the Owner;
 - 2. Legal mailing address of the Owner;
 - 3. State of business formation and type;
 - 4. The names and respective titles of the two individuals authorized to execute the agreement; and,
 - 5. A concise narrative of the project
- D. All applications shall be accompanied with a copy of all design and construction plans as well as specifications and engineering computations for the proposed occupancy. Included shall be a plan showing the extent of the total project upon which that portion of the work affecting the JRA property is clearly defined.
- E. All of the above plans, specifications, and computations must be prepared by, and bear the seal of, a Professional Engineer.

1.4 Right of Entry

- A. Entry upon the JRA property for the purpose of conducting surveys, field inspections, obtaining soils information, or any other purpose associated with the design and construction for the proposed occupancy, will not be permitted without a proper entry permit prepared by the Property Manager. The applicant must pay the associated fees and execute the entry permit.
- B. The issuance of an entry permit does not constitute authority to proceed with any construction. Construction cannot begin until a formal agreement is executed by the JRA and the Owner receives permission, from the Property Manager, to proceed with the work.
- C. Upon issuance of the entry permit, the Licensee shall contact the Director of Operations for the railroad at (570) 473-7949 to begin the process of securing a Railroad Flagging Agreement for access to the railroad and associated protective services.

1.5 Site Inspections

- A. For longitudinal occupancy of the JRA property, a site inspection along the proposed pipeline route may be required before final design plans are prepared. When a site inspection is required, the Applicant's engineer must meet with the Property Manager or his designated representative to view the entire length of the proposed occupancy; the Applicant will be informed of the need for a meeting during application processing.
- B. Prior to the site inspection the Applicant must submit the following information:
 - 1. A plan view of the proposed route showing all tracks, both JRA right-of-way lines, and all other facilities located on the right-of-way. The distance from the proposed pipeline to the adjacent track and to the right-of-way lines must be shown.
 - 2. A complete "Pipe Data Sheet" – (See Plate I)
 - 3. Typical cross sections along the proposed route - (See Plate V)
- C. Site inspections for transverse pipe crossings are generally not required except where, in the discretion of the Property Manager, the size and location of the facility warrant an inspection.

1.6 Information Required for Submission – Plans, Computations, and Specifications

- A. All plans, computations, and specifications shall be submitted as per the instructions in the applications package. Failure to follow these instructions may result in the return of the application and accompanying information without further action being taken by the JRA.
- B. Plans, computations, and specifications for the proposed pipeline occupancy are to be submitted to the Property Manager and approved by the Engineer prior to issuance of an agreement and start of construction.
- C. Plans are to be prepared in sizes that are as small as practical and shall be folded, individually, by the applicant to an 8-1/2 inch x 11 inch size prior to submission. Where more than one plan is involved, the folded plans shall be assembled into complete sets by the applicant before submission. Failure of the applicant to comply with these requirements may result in rejection of the application.
- D. Plans shall be drawn to scale and shall include the following (See Plates I to VII):
 - 1. Plan view of the proposed pipeline in relation to all JRA facilities and facilities immediately adjacent to the JRA including, but not limited to, tracks, buildings, signals, pole lines, other utilities and all other facilities that may affect or influence the pipeline design and construction. (See Plate II)
 - 2. The location (in feet) of the pipe from the nearest JRA Milepost and / or from the centerline of a JRA bridge, giving the JRA bridge number.
 - 3. In all cases, the name of the State, County, and Municipality in which the proposed facilities are located must be shown.
 - 4. The profile of the ground above the centerline of the pipe, from field survey, showing relationship of the pipeline and / or casing pipe to the ground levels, the tracks and other facilities. (See Plate III)

5. For longitudinal occupations, the profile of the adjacent track, or tracks, shall be shown. (See Plate IV)
 6. All JRA property lines indicated by dimensions, in feet, to the centerline of the adjacent track as well as the overall width of the JRA right-of-way.
 7. If the pipeline is in a public highway, the limits of the dedicated highway right-of-way, as well the limits of any paving, sidewalks, etc., shall be defined, by dimensions in feet, from the centerline of the dedicated right-of-way.
 8. The angle of the crossing in relation to the centerline of the track(s).
 9. On pipelines having valves, the distance in feet along the pipeline from the crossing to the nearest valves and / or control stations.
 10. A separate "Pipe data sheet" (See Plate I) shall be submitted on 8-1/2 inch x 11 inch sheet size for each crossing.
- E. With respect to occupations which will be on JRA property and under tracks that are not on JRA property, any plan submitted shall be specific as to:
1. The method of installation;
 2. The size and material of the casing pipe; and,
 3. The size and material of the carrier pipe.
- These items cannot have an alternative and any application that is received that indicates options in any of the above items will not be processed.
- F. Once the application has been approved by the Property Manager, no variance from the plans, specifications, method of installation, constructions, etc., as approved in the occupancy document, shall be considered or permitted without the payment to JRA of additional fees for the re-processing of the application.
- G. All plans, computations, and specifications associated with the work under the agreement shall be prepared by, and bear the seal of, a Professional Engineer. If not so imprinted, the application shall be given no further consideration. This requirement applies equally to all data submitted by the Applicant's contractor. Any plans or computations submitted by any contractor which are not stamped by a Professional Engineer shall be returned and construction shall not be permitted to proceed.
- H. All plans should be submitted to the Property Manager via email unless otherwise instructed.

1.7 Notification to Proceed with Construction

- A. After approval of the plans, computations, and specifications and execution of the occupational agreement, the Applicant/Owner will be notified by the Property Manager or the appropriate JRA designated contact, who must be contacted prior to start of construction. The appropriate JRA designated contact shall have the discretion to inspect the project and coordinate all other construction aspects of the project which relate to the JRA operations; i.e., flagging, track work, protection of signal cables, etc.
- B. Applicant shall pay all costs of inspection by the JRA designee or Engineer.

- C. The JRA's designated contact must be notified at least fourteen (14) working days prior to the desired start of construction.

Section 2.0 GENERAL REQUIREMENTS

2.1 Use of Casing Pipe

- A. A casing pipe will be required for all pipeline crossings carrying oil, gas, petroleum products, or other flammable or highly volatile substances under pressure, and all non-flammable substances which, from their nature or pressure, as determined by the Engineer, might cause damage if escaping on or near JRA Property. The Engineer may nonetheless recommend, in certain cases (*e.g.* where there is adequate depth of installation), that the encasement requirement be waived. Under such circumstances, the Property Manager shall have discretion to waive the encasement requirement.
- B. For non-pressure sewer or drainage crossings where the installation can be made without interference to railroad operations; *i.e.*, such as jack and bore, and as reviewed and approved by the Engineer, no casing pipe shall generally be required.
- C. Pressure pipelines which do not cross under the track but which are located within 25 feet of the centerline of any track or closer than 45 feet to the nearest point of any bridge, building or other important structure shall be encased.
- D. At proposed pipe crossings the casing pipe shall be laid across the entire width of the right-of-way, except where a greater length is required to comply with the Design Requirements – Casing Pipe Section of these specifications, even though such extension is beyond the right-of-way.
- E. At the sole discretion of the Property Manager, a casing pipe may be required for any application, regardless of the commodity carried.

2.2 Location of Pipeline on the Right-of-Way

- A. Pipelines laid longitudinally on JRA's right-of-way shall be located as far as practicable from any tracks or other important structures and as close to the railroad property line as possible. Longitudinal pipelines must not be located in earth embankments or within ditches located on the right-of-way.
- B. Pipelines shall be located, where practicable, to cross tracks at approximate right angles to the track, but preferably not at angles of less than 45 degrees.
- C. Pipelines shall not be placed within a culvert, under railroad bridges, nor closer than 45 feet to any portion of any railroad bridge, building, or other important structure, except in special cases, and then by special design, as approved by the Property Manager and Engineer.
- D. Pipelines shall not be located within the limits of a turnout (switch) when crossing a track. The limits of the turnout extend from the point of the switch to 15 feet beyond the last long timber.
- E. Where possible, pipelines shall not be located within the limits of an at-grade crossing when open cut is the method of installation. If it is shown that no other method of installation is possible, the Applicant/Owner will be responsible for reimbursing the JRA

for all costs associated with the removal and reconstruction of the grade crossing. This cost shall require advance funding by the Applicant/Owner of the pipeline.

- F. Pipelines carrying liquefied petroleum gas shall, where practicable, cross the railroad where tracks are carried on embankment.

2.3 Depth of Installation

1. Pipelines conveying non-flammable substances
 - a. Casing / carrier pipes placed under JRA track(s) shall be not less than 7.0 feet from base of rail to top of pipe at its shallowest point within the JRA right-of-way.
 - b. Pipelines laid longitudinally on JRA right-of-way, 50 feet or less from centerline of track shall be buried not less than four (4) feet from ground surface to top of pipe.
 - c. Where the pipeline is laid more than 50 feet from the centerline of track, the minimum cover shall be at least three (3) feet.
2. Pipelines conveying flammable substances
 - a. Casing pipes under JRA track(s) shall not be less than 7.0 feet from base of rail to top of pipe at its closest point. On other portions of the right-of-way, where the pipe is not directly beneath any track, the depth from ground surface or from bottom of ditch to top of pipe shall not be less than 3 feet. Where 3 feet of cover cannot be provided from bottom of ditch, a 6-inch thick reinforced concrete slab shall be provided over the pipeline for protection.
 - b. Pipelines laid longitudinally on JRA's right-of-way, 50 feet or less from centerline of track but no closer than 20 feet from track centerline (if existing right-of-way is wide enough) shall be buried not less than 6 feet from ground surface to top of pipe. If the existing right-of-way is 20 feet or less from track centerline the longitudinally laid pipe shall be no closer than 15 feet from track centerline. Where the pipeline is laid more than 50 feet from centerline of track, the minimum cover shall be at least 5 feet.

2.4 Pipelines within Limits of a Dedicated Highway

1. Pipelines within the limits of a dedicated highway are subject to all the requirements of these specifications and must be designed and installed in accordance with these specifications.
2. The limits of the dedicated highway (right-of-way) must be clearly shown on the plans.
3. Construction shall not begin until an agreement has been executed between the JRA and the Applicant/Owner of the pipeline and proper notification has been given to the Property Manager or his designated contact. See Section 1.7.

2.5 Modification of Existing Facilities

1. Any replacement or modification of an existing carrier pipe and/or casing shall be considered as a new installation, and shall therefore be subject to all the requirements of these specifications.

2.6 Abandoned Facilities

1. The Owner of all pipe crossings proposed for abandonment shall notify the JRA, in writing, of the intention to abandon.
2. Abandoned pipelines shall be removed or completely filled with cement grout, compacted sand, or other methods, as approved by the Property Manager or Engineer.
3. Abandoned manholes and other structures shall be removed to a minimum depth of six (6) feet below finished grade and completely-filled with cement grout, compacted sand, or other methods as approved by the Property Manager or Engineer.

2.7 Conflict of Specifications

1. Where laws or orders of public authority prescribe a higher degree of protection than specified herein, then the higher degree so prescribed shall be deemed a part of this specification.

2.8 Insulation

1. Pipelines and casings shall be adequately insulated from underground conduits carrying electric wires on JRA property to prevent infiltration or interference from electrical currents.

2.9 Corrosion Protection and Petroleum Leak Protection

1. Pipelines on JRA property that carry petroleum products or hazardous liquids shall be designed in accordance with current federal, state, and/or local regulations that mandate leak detection automatic shutoff, leak monitoring, sacrificial anodes, and/or exterior coatings to minimize corrosion and prevent petroleum releases.

2.10 Plastic Carrier Pipe Materials

1. Plastic carrier pipe materials include, but are not limited to thermoplastic and thermoset plastic pipes. Thermoplastic types include Polyvinyl Chloride (PVC), Acrylonitrile Butadiene Styrene (ABS), High Density Polyethylene (HDPE), Polyethylene (PE), Polybutylene (PB), Cellulose Acetate Butyrate (CAB), and Styrene Rubber (SR). Thermoset types include Reinforced Plastic Mortar (RPM), Reinforced Thermosetting Resin (FRP), and Fiberglass Reinforced Plastic (FRP).
2. Plastic carrier pipelines shall be encased according to American Railway Engineering and Maintenance-of-Way Association (AREMA) Manual Chapter 1 Section 5.1.5, or the most current successor provision addressing Guidelines for Pipelines Conveying Flammable Substances.
3. Plastic pipe material shall not be used to convey liquid flammable substances.

4. Plastic pipe material shall be resistant to the chemicals with which contact can be reasonably anticipated. Plastic carrier pipe shall not be utilized where there is potential for contact with petroleum contaminated soils or other non-polar organic compounds that may be present in surrounding soils.
5. Plastic carrier pipe may be utilized to convey flammable gas substances, provided the pipe material is compatible with the type of substance conveyed and the maximum allowable operating pressure is less than 100 PSI. Carrier pipe materials, design, and installation shall conform to Code of Federal Regulations 49 CFR § 178.1 through §199, and specifically §192 (relating to “Transportation of Natural and Other Gas by Pipeline: Minimum Federal Safety Standards”), as well as American National Standards Institute (ANSI), American Society of Mechanical Engineers (ASME) B31.8 (relating to “Gas Transmission and Distribution Piping Systems”) and American Society for Testing and Materials (ASTM) D2513 (relating to “Standard Specification for Polyethylene (PE) Gas Pressure Pipe, Tubing, and Fittings”).
6. Codes, specifications, and regulations current at time of construction of the pipeline shall govern the installation of the facility within the railway right-of-way. The proof testing of the strength of carrier pipe shall be in accordance with ANSI requirements. Plastic carrier pipes will be encased according to AREMA Chapter 1 Section 5.1.5, or the most current successor provision addressing the same subject matter.
7. The encasements for plastic carrier pipe conveying flammable substances shall extend to the entire limits of the right-of-way. If special conditions exist which prevent encasement extending to the entire limits of the right-of-way, the Engineer must approve the minimum encased length.
8. Plastic carrier pipe must be encased under all tracks, including sidings and industrial tracks within the limits of the right-of-way.
9. Longitudinal carrier pipeline shall be steel or ductile iron. Plastic carrier pipe may be utilized for longitudinal installation only with approval by the Engineer, and, where approved, shall be fully encased within the limits of the right-of-way.
10. Codes, specifications, and regulations current at the time of construction of the pipeline shall govern the installation of the facility within the railway rights-of-way. The proof testing of the strength of carrier pipe shall be in accordance with ANSI requirements.

<u>Specification Number</u>	<u>Carrier Pipe Properties</u>
ANSI/AWWA C900	PVC pressure pipe 4” through 12”
ANSI/AWWA C901	PE pressure pipe and tubing ½” through 3” for water
ANSI/AWWA C902	PE pressure pipe and tubing ½” through 3” for water
ANSI/AWWA C905	PVC water pipe, 14” through 36”
ANSI/AWWA C906	PE pressure pipe and fittings 4” through 63” for water
ANSI/AWWA C907	PVC pressure fittings 4” through 8”
ANSI/AWWA C950	Fiberglass pressure pipe

Section 3.0 SOIL INVESTIGATION

3.1 General

1. Test borings or other soil investigations approved by the Property Manager or Engineer shall be made in order to determine the nature of the underlying material for all pipe crossings with casing pipe sizes greater or equal to 48 inches in diameter and larger under tracks(s).
2. Test borings or other soil investigations, approved by the Property Manager or Engineer, may be required when, in the judgment of the JRA, they are necessary to determine the adequacy of the design and construction of pipe crossings with casings of less than 48 inches in diameter and for other facilities located in the right-of-way. Note: the Applicant shall be responsible for the notification of all underground utilities including JRA signal cables.

3.2 Location

1. Borings shall be made on each side of the track(s), on the centerline of the pipe crossing, and as close to the track(s) as practicable.
2. Test boring logs shall accompany a plan, drawn to scale, showing the location of the borings in relation to the track(s) and the proposed pipe.

3.3 Sampling

1. Test borings shall be made in accordance with current ASTM Designation D 1586 or any successor except that sampling must be continuous from the ground surface to 5 feet below the proposed invert unless rock is encountered before this depth. Where rock is encountered, it is to be cored using a Series "M" Double Tube Core Barrel, with a diamond bit, capable of retrieving a rock core at least 1-5/8" in diameter. Individual core runs are not to exceed 5 feet in length.
2. All borings shall be sealed, for their full depth, with a 4-3-1 bentonite-cement-sand grout after accurate ground water readings have been taken and recorded.
3. Soil samples taken from auger vanes or return washwater are not acceptable.

3.4 Boring Logs

1. Test boring logs shall comply with Plate VIII and clearly indicate **all** of the following:
 - a. Boring number as shown on the required boring location plan;
 - b. Ground elevation at each boring using same datum as the pipeline construction plans;
 - c. Engineering description of soils or rock encountered;
 - d. Depth and percent recovery of all soil samples;
 - e. Depth from surface for each change in strata;
 - f. Blows for each 6 inches of penetration for the standard penetration test described in ASTM D 1586. Blows for lesser penetrations should be recorded.
 - g. Percent recovery and Rock Quality Designation (RQD) for all rock cores; and,
 - h. Depth to ground water while sampling and when it has stabilized in the bore hole.
2. The location of the carrier pipe and/or casing pipe shall be superimposed on the boring logs before submission to the JRA.

3. All borings shall be sealed, for their full depth, with a 4-3-1 bentonite-cement-sand grout after accurate ground water readings have been taken and recorded.
4. Soil samples taken from auger vanes or return washwater are not acceptable.

3.5 Additional Information

1. When directed by the Property Manager or Engineer, additional borings may be required for the purpose of taking undisturbed thin-wall piston samples or Dennison type samples for laboratory testing to determine the index and engineering properties of certain soil strata.
2. If, during the boring (vertical or horizontal) a misalignment or blow out is experienced, the JRA shall be notified immediately, the boring shall be abandoned in place, and immediately filled with grout. Under such circumstances, before work may resume, a new boring procedure and revised plans must be submitted to, and approved by, the JRA and the Engineer.

Section 4.0 DESIGN REQUIREMENTS

4.1 Design Loads

1. General Requirements
 - a. All pipes, manholes, and other facilities shall be designed for (or in excess of) the external and internal loads to which they will be subjected.
 - b. To allow for placement of additional track(s) or shifting of the existing track(s), all proposed pipelines or structures shall be designed as if a railroad loading is directly above the facility.
2. Earth Loads
 - a. The dead load of the earth shall be considered as 120 pounds per cubic foot unless soil conditions warrant the use of a higher value.
3. Railroad Loads (live load and impact)
 - a. The railroad live load used shall be a Cooper E-80 loading. This loading consists of 80 kip axle loads spaced 5 feet on centers
 - b. An impact factor of 1.75 (multiply live load by the impact factor) shall be used for depth of cover up to 5 feet. Between 5 and 30 feet of cover, the impact factor is reduced by 0.03 per foot of depth. Below a depth of 30 feet, the impact factor is one.
 - c. The values shown in Table 1 shall be used for the vertical pressure on a buried structure for the various heights of cover.

Table 1 – Live loads, including impact, for various heights of cover for a Cooper E-80 loading

Height of Cover	Load (Pound per square foot)
2	3800
3	3150
4	2850
5	2550
6	2250
7	1950
8	1700
9	1500
10	1300
12	1000
14	800
16	625
18	500
20	400
25	150
30	150

- d. To determine the horizontal pressure caused by the railroad loading on a sheet pile wall or other structure adjacent to the track, the Boussinesq analysis shall be used. The load on the track shall be taken as a strip load with a width equal to the length of the ties which is typically, 8.5 feet. The vertical surcharge, q (psf), caused by each axle, shall be uniform and equal to the axle load divided by the tie length and the axle spacing, 5 feet. For the E-80 loading this results in;

$$q = 80,000 / (8.5 \times 5) = 1882 \text{ psf}$$

The horizontal pressure due to the live load surcharge at any point on the wall or other structure is P_h and can be calculated by the following:

$$P_h = (2q/\pi)(\beta - \sin \beta(\cos 2\alpha)) \text{ (See Plate IX)}$$

- e. The vertical and horizontal pressures given above shall be used unless an alternate design method is approved by the Engineer. Proposals to use an alternate design method must include acceptable references and a statement explaining the justification for choosing the alternate method.

4.2 Design Assumptions

To design a casing pipe or an uncased carrier pipe for the external loads on JRA's right-of-way, the following design assumptions shall be used, unless site conditions indicate more conservative values are required:

1. Flexible Pipe (Steel, DIP, CMP, Tunnel Liner Plate)
 - a. Steel Pipe (Bored and jacked in place)
 - i) Spangler's Iowa formula shall be used for design with:

- Deflection lag factor - $D_f = 1.5$
 - Modulus of soil reaction - $E' = 1080 \text{ psi}$
 - Bedding constant - $K_b = 0.096$
 - Soil loading constant - $K_u' = 0.13$
 - Allowable deflection of pipe - 3% of pipe diameter
 - b. Ductile Iron Pipe (open cut)
 - i) AWWA Specification C150 shall be used for design with:
 - Pipe laying condition - Type 3
 - Earth load - ANSI A 51.50 prism method
 - c. Corrugated Steel Pipe & Corrugated Structural Steel Plate Pipe (open cut)
 - i) AREMA Chapter 1, Sections 4.9 & 4.10 shall be used for design with:
 - Soil stiffness factor - $K = 0.33$
 - Railroad impact as per Design Requirements – Casing Pipe Section of these specifications
 - d. Tunnel Liner Plate (Tunneled)
 - i) AREMA Chapter 1, Part 4, Section 4.16 shall be used for design with:
 - Soil stiffness factor - $K = 0.33$
 - Railroad impact as per Design Requirements – Casing Pipe Section of these specifications
2. Rigid Pipe (RCP, Vitrified Clay Pipe and PCCP)
- a. Reinforced Concrete Pipe, Vitrified Clay Pipe and Prestressed Concrete Cylinder Pipe (open cut)
 - i) American Concrete Pipe Association design manual shall be used for design with:
 - Marston load theory used for earth load
 - Bedding (load factor) - $L_f = 1.9$
 - Factor of Safety - $FS = 1.25$ for RCP
 $FS = 1.5$ for VCP
 - Railroad impact as per Design Requirements – Casing Pipe Section of these specifications
 - b. Reinforced Concrete Pipe (jacked)
 - i) American Concrete Pipe Association (ACPA) design manual shall be used for design with:
 - Marston load theory used for earth load
 - Bedding (load factor) - $L_f = 3.0$
 - Factor of Safety - $FS = 1.25$
 - Railroad impact as per Design Requirements – Design Loads Section of these specifications
 - Others - As approved by the Engineer

4.3 Casing Pipe

1. General Requirements

- a. Casing pipe shall be so constructed as to prevent leakage of any substance from the casing throughout its length, except at ends of casing where ends are left open, or through vent pipes when ends of casing are sealed. Casing shall be installed so as to prevent the formation of a waterway under the railroad, and with an even bearing throughout its length, and shall slope to one end (except for longitudinal occupancy).
 - b. The casing pipe and joints shall be of steel and of leak proof construction when the pipeline is carrying liquid flammable products or highly volatile substances under pressure.
 - c. The inside diameter of the casing pipe shall be such as to allow the carrier pipe to be removed subsequently without disturbing the casing or the roadbed. For steel pipe casings, the inside diameter of the casing pipe shall be at least 2 inches greater than the largest outside diameter of the carrier pipe joints or couplings, for carrier pipe less than 6 inches in diameter; and at least 4 inches greater for carrier pipe 6 inches and over in diameter.
 - d. For flexible casing pipe, a maximum vertical deflection of the casing pipe of three percent (3%) of its diameter, plus ½ inch clearance shall be provided so that no loads from the roadbed, track, traffic, or casing pipe itself are transmitted to the carrier pipe. When insulators are used on the carrier pipe, the inside diameter of the flexible casing pipe shall be at least 2 inches greater than the outside diameter of the carrier pipe for pipe less than 8 inches in diameter; at least 3-1/4 inches greater for pipe 8 inches to 16 inches, inclusive, in diameter and at least 4-1/2 inches greater for pipe 18 inches and over in diameter.
 - e. Subject to the foregoing the casing pipe diameter shall not be larger than is necessary to permit the insertion of the carrier pipe.
 - f. Casing pipe under railroad tracks and across JRA's right-of-way shall extend the **greater** of the following distances, measured at right angles to the centerline of track:
 - i) Across the entire width of the JRA right-of-way;
 - ii) 3 feet beyond ditch line;
 - iii) 2 feet beyond toe of slope
 - iv) A minimum distance of 25 feet from each side of the centerline of outside track when casing is sealed at both ends;
 - v) A minimum distance of 45 feet from centerline of outside track when casing is open at both ends;
 - vi) Beyond the theoretical railroad embankment line. This line begins at a point that is 10 feet horizontally from centerline track, 18 inches below top of rail, and extends downward on a 1-1/2(H) to 1(V) slope. (See Plate III)
 - g. If additional tracks are constructed in the future, the casing shall be extended consistent with the foregoing at the Owner's expense.
2. Steel Pipe
- a. Steel pipe may be installed by open cut, boring or jacking depending on the situation.
 - b. Steel pipe shall have a Specified Minimum Yield Strength, (SMYS), of at least 35,000 psi. The ASTM or American Petroleum Institute (API) specification and grade for the pipe are to be shown on the application form.
 - c. Joints between sections of pipe shall be fully welded around the complete circumference of the pipe.

- d. Steel casing pipe, with a minimum cover of 7 feet from base of rail, shall have a minimum wall thickness as shown in Table 2, unless computations indicate that a thicker wall is required.

Table 2

<u>Pipe Diameter Nominal Size (in.)</u>	<u>Coated or Cathodically Protected Nominal Wall Thickness (in.)</u>	<u>Uncoated and Unprotected Nominal Wall thickness (in.)</u>
10 and under	0.188	0.188
12 & 14	0.188	0.250
16	0.219	0.281
18	0.250	0.312
20 & 22	0.281	0.344
24	0.312	0.375
26	0.344	0.406
28	0.375	0.438
30	0.406	0.469
32	0.438	0.500
34 & 36	0.469	0.532
38	0.500	0.562
40	0.531	0.594
42	0.562	0.625
44 & 46	0.594	0.657
48	0.625	0.688
50	0.656	0.719
52	0.688	0.750
54	0.719	0.781
56 & 58	0.750	0.812
60	0.781	0.844
62	0.812	0.875
64	0.844	0.906
66 & 68	0.875	0.938
70	0.906	0.969
72	0.938	1.000

- e. Coated steel pipe that is bored or jacked into place shall conform to the wall thickness requirements for uncoated steel pipe since the coating may be damaged during installation.
- f. Smooth wall steel pipes with a nominal diameter over 72 inches will not be permitted.

3. Ductile Iron Pipe

- a. Ductile Iron Pipe may be used only at the sole discretion of the Property Manager or Engineer when placed by the open cut method. Jacking or boring through the railroad embankment is not permitted due to the bell and spigot joints.

- b. Ductile iron pipe shall conform to the requirements of ANSI A21.51 / AWWA C-151. Class 56 pipe shall be used unless computations, in accordance with the Design Requirements – Design Loads and Design Assumptions sections, are provided. Even where computations are provided, deviation from the requirement that Class 56 pipe shall be used shall be subject to the discretion of the Engineer.
 - c. The pipe shall have mechanical or push on type joints.
4. Corrugated Steel Pipe and Corrugated Structural Steel Plate Pipe
- a. Corrugated steel pipe and corrugated structural steel pipe may be used for a casing only when placed by the open cut method. Jacking or boring through the railroad embankment is prohibited.
 - b. Corrugated steel pipe and corrugated structural steel pipe may be used for a casing provided the pressure in the carrier pipe is less than 100 psi.
 - c. Pipe shall be bituminous coated and shall conform to the current AREMA Specifications, Chapter 1, Part 4, or such successor provision addressing the same subject matter.
 - d. Corrugated steel pipe shall have a minimum sheet thickness as shown in Table 3. Corrugated structural steel plate pipe shall have a minimum plate thickness of 8 gauge, 0.168 inch. If computations indicate that a greater thickness is required, the thicker sheet or plate shall be used. This determination shall be at the ultimate discretion of the Engineer.

Table 3

Pipe Diameter (inches)	Sheet Thickness:	(inches)	(gage)
12 to 30		0.079	14
36		0.109	12
42 to 54		0.138	10
60 to 120		0.168	8

5. Steel Tunnel Liner Plates
- a. Liner plates shall be installed by the tunneling method as detailed in the Construction Requirements – Method of Installation Section of these specifications.
 - b. Tunnel liner plates shall be galvanized and bituminous coated and shall conform to current AREMA guidelines. If the tunnel liner plates are used only to maintain a tunneled opening until the carrier pipe is installed, and the annular space between the carrier pipe and the tunnel liner is completely filled with cement grout within a reasonably short time after completion of the tunnel, then the tunnel liner plates need not be galvanized or coated. What constitutes a “reasonably short time after” shall be subject to the discretion of the Engineer under the particular circumstances.
 - c. Tunnel liner plates are to be a minimum of 12 gauge and shall be fabricated from structural quality, hot-rolled, carbon-steel sheets or plates conforming to ASTM Specification A 1011.
 - d. The following liner plate information must be shown on the Application Form:
 - i) Number of flanges (2 or 4)
 - ii) Width of plate

- iii) Type of plate (smooth or corrugated)
6. Reinforce Concrete Pipe
- a. Reinforced concrete pipe shall be installed by the open cut (at the sole discretion of the Engineer) or jacking method.
 - b. Reinforced concrete pipe shall conform to ASTM Specification C 76, Class V pipe, Wall B or C shall be used unless computations, in accordance with the Design Requirements – Design Assumptions, are provided. Even where computations are provided, deviation from these standards shall be subject to the discretion of the Engineer.
 - c. Reinforced concrete pipe may be used for a casing provided the pressure in the carrier pipe is less than 100 psi.
 - d. Pipe placed by open cut shall be installed in accordance with AREMA Guidelines except that backfill and compaction shall be in accordance with the Construction Requirements – Method of Installation Section of these specifications.
 - e. Pipe jacked into place shall have tongue and groove joints and shall be installed in accordance with the Construction – Requirements – Method of Installation Section of these specifications.
 - f. Joint between sections of the RCP shall be sealed with a gasket conforming to ASTM C 443 or approved equivalent.
7. Concrete Encasement
- a. At locations where the installation is by open cut and a casing pipe is required, but cannot be installed due to elbows or other obstructions, concrete encasement may be used when approved by the JRA Engineer.
 - b. The concrete encasement must provide a minimum cover of 6 inches of concrete around the pipe. A 6 x 6 – W 2.9 x W 2.9 welded wire fabric shall be placed in the concrete on all sides.

4.4 Carrier Pipe

1. General Requirements
- a. Carrier pipes with a casing shall be designed for railroad live loads as if they were not encased.
 - b. The pipe shall be laid with sufficient slack so that it is not in tension.
 - c. Steel pipe shall not be used to convey sewage, storm water, or other liquids that could cause corrosion.
 - d. Carrier pipes located on JRA's right-of-way or under JRA tracks, on which railroad operations occur, shall be manufactured in accordance with the following specifications:
 - 1) Steel pipe – The ASTM or API specification and grade for the pipe is to be shown on the Application Form. The SMYS is to be at least 35,000 psi. For flammable substances, see the Design Requirements – Carrier Pipe Section of this document for additional requirements. The minimum wall thickness shall be in accordance with Table 2 of these specifications.
 - 2) Ductile Iron Pipe – ANSI A21.51 / AWWA C 151, Class 56

- 3) Corrugated Metal Pipe – AREMA Chapter 1, Part 4; minimum gauge of pipe to be in accordance with Table 3 of these specifications.
 - 4) Reinforced Concrete Pipe – ASTM C 76, Class V, Wall C
 - 5) Vitrified Clay Pipe – ASTM C 700, Extra Strength
 - 6) Prestressed Concrete Cylinder Pipe – AWWA C 301
 - 7) Reinforced Concrete Cylinder Pipe – AWWA C 300
 - 8) Others – As approved by the Engineer
- e. Carrier pipes installed within a casing pipe shall be designed for the internal pressure to which it will be subjected.
 - f. Gravity flow carrier pipes, installed within a casing pipe, shall meet the requirements, of the particular pipe material, as given in Design Requirements – Casing Pipe Section of these specifications.
 - g. Design computations, stamped by a Professional Engineer, must be submitted for all uncased pressure pipelines installed on JRA’s right-of-way. The pipe must be designed for the internal and external loads (see the Design Requirements Section of this document) to which it may be subjected. The design assumptions give in Design Requirements Section shall apply. Even where computations are provided, final discretion as to whether a casing pipe shall be required is vested in the Engineer.

4.5 Pipelines Carrying Flammable Substances

1. Pipelines, carrying oil, liquefied petroleum gas, and other flammable products shall be of steel and conform to the requirements of the current ASME B 31.4 Liquid Transportation Systems for Hydrocarbons, Liquid Petroleum Gas, Anhydrous Ammonia, and Alcohols, and other applicable ASME codes, except that the maximum allowable stresses for design of steel pipe shall not exceed the following percentages of the SMYS (multiplied by the longitudinal joint factor) or the pipe as defined in the above codes:
2. The following percentages apply to hoop stress in steel pipe within a casing under railroad tracks, across railroad right-of-way and longitudinally on railroad right-of-way:
 - a. Seventy-two percent (72%) on oil pipelines
 - b. Sixty percent (60%) for installations on gas pipelines
 - c. Fifty percent (50%) for pipelines carrying condensate, natural gasoline, natural gas liquids, liquefied petroleum gas, and other liquid petroleum products
3. The following percentages apply to hoop stress in steel pipe laid longitudinally on railroad right-of-way without a casing:
 - a. Sixty percent (60%) for oil pipelines
 - b. Forty percent (40%) for pipelines carrying condensate, natural gasoline, natural gas liquids, liquefied petroleum gas, and other liquid petroleum products
 - c. Forty percent (40%) for gas pipelines
4. Computations, based on the above requirements and stamped by a Professional Engineer shall be submitted with the application for occupancy.

4.6 Uncased Pipelines Carrying Gas

1. Pipelines carrying flammable and nonflammable gas products shall be steel (Pipelines carrying non-flammable gas products may be plastic) and shall conform to the

requirements of the current ASME B 31.8 Gas Transmission and Distribution Piping Systems, and other applicable ANSI codes.

2. The minimum wall thickness for uncased carrier pipe shall be in accordance with the values provided in AREMA, Chapter 1, Part 5.
3. A durable coating, which will resist abrasion (fusion bonded epoxy or other suitable material), shall be used to protect the uncased pipeline when the boring method of installation is used.
4. If the Engineer determines that there is a potential for damage to the uncased pipeline (foreign material in the subgrade, third party damage, etc.), special protection of the pipeline will be required. Special protection may include the use of concrete jacketed carrier pipe, a protection slab over the pipeline, increased depth of bury, or other means approved by the Engineer.

4.7 Casing Pipe End Seals

1. Casings for carrier pipes of flammable and hazardous substances shall be suitably sealed to the outside of the carrier pipe. Details of the end seals shall be shown on the plans.
2. Casings for carrier pipes of non-flammable substances shall have both ends of the casing blocked up in such a way as to prevent the infiltration of foreign material, but allowing leakage to pass outward in the event of a carrier leak.
3. The ends of a casing pipe may be left open when the ends are at or above ground surface and above high water level, provided drainage is afforded in such a manner that leakage will be conducted away from railroad tracks and structures.

4.8 Vents

1. Sealed casings for flammable substances shall be properly vented. Vent pipes shall be of sufficient diameter, but in no case less than two inches in diameter, and shall be attached near each end of the casing and project through the ground surface at right-of-way lines or not less than 45 feet, measured at right angles from centerline of nearest track.
2. Vent pipes shall extend not less than four (4) feet above the ground surface. The top of the vent pipe shall have a down-turned elbow, properly screened, or a relief valve. Vents in locations subject to high water shall be extended above the maximum elevation of high water and shall be supported and protected in a manner approved by the Engineer.
3. Vent pipes shall be at least four (4) feet, vertically, from aerial electric wire or greater if required by the National Electrical Safety Code (ANSI C2).
4. When the pipeline is in a public highway, street-type vents shall be installed.

4.9 Signs

1. All pipelines (except those in streets where it would not be practical to do so) shall be prominently marked at right-of-way lines (on both sides of track for crossings) by durable, weatherproof signs located over the centerline of the pipe. Signs shall show the following:
 - Name and address of Owner
 - Contents of pipe

Pressure in pipe
Pipe depth below grade at the point of the sign
Emergency telephone number in event of pipe rupture
JRA Agreement number
Railroad Mile Pole
Final latitude / longitude as constructed

2. For pipelines running longitudinally on the JRA property, signs shall be placed over the pipe (or offset and appropriately marked) at all changes in direction of the pipeline. Such signs should also be located so that when standing at one sign the next adjacent marker in either direction is visible. In no event shall they be placed more than 500 feet apart unless otherwise specified by the JRA.
3. The Owner shall maintain all signs on the JRA right-of-way as long as the occupations agreement is in effect. Failure to do so may result in the JRA erecting new signs and invoicing their cost, plus the cost of their installation, including any surveying costs, to the Owner.

4.10 Warning tape

1. All pressure pipelines installed by the trench method, without a casing, shall have a warning tape placed directly above the pipeline, two (2) feet below the ground surface.

4.11 Shut-off valves

1. Accessible emergency shut-off valves shall be installed within effective distances but no greater than 2,000 feet on both sides of the pipeline crossing or longitudinal occupancy.
2. Location of the valves shall be chosen to guard against any hazard to life and property and shall therefore be in compliance with United States Department of Transportation, minimum Federal Safety Standards as set forth in 49 CFR 192 or any successor provision covering the same subject matter, or at the discretion of the Engineer.

4.12 Cathodic Protection

1. Cathodic protection shall be applied to all pipelines carrying flammable substances in, over, or through the JRA's right-of-way.
2. For crossing and at other locations where the pipeline must be placed within a casing, the casing is to have cathodic protection or the wall thickness is to be increased to the requirements of the Design Requirements Section Table 2.
3. Uncased gas carrier pipes must be coated and cathodically protected to industry standards and test sites, for monitoring the pipeline, shall be provided within 50 feet of each such crossing.
4. Where casing and/or carrier pipes are cathodically protected by any means other than anodes, the JRA shall be notified and a suitable test made to ensure that other railroad structures and facilities are adequately protected from the cathodic current in accordance with the recommendation of current Reports of Correlating Committee on Cathodic Protection, published by the National Association of Corrosion Engineers (NACE).

5. Where sacrificial anodes are used, the locations shall be marked with durable signs. The Owner shall maintain such signs on the JRA right-of-way as long as the occupations agreement is in effect. Failure to do so may result in the JRA erecting new signs and invoicing their cost, plus the cost of their installation, including any surveying costs, to the Owner.

4.13 Manholes

1. Manholes on JRA property are generally discouraged. At locations where manholes are absolutely necessary, including longitudinal occupancies, manholes shall be precast concrete sections conforming to ASTM Designation C 478, "Specification for Precast Concrete Manhole Sections", or such successor provision addressing the same subject matter.
2. The top of manholes located on JRA property shall be flush with top of ground.
3. The distance from the centerline of the manhole to the centerline of the nearest adjacent track shall be no less than 15 feet or no less than the maximum reach of the ballast regulator plus six feet.
4. The distance from centerline of adjacent track to centerline of the proposed manhole shall be shown on the plans.

4.14 Box Culverts

1. Reinforced concrete box culverts shall be designed in conformance with the requirements of the JRA and the current AREMA specifications, Chapter 8, or any successor provisions addressing the same subject matter.

4.15 Drainage

1. Occupancies shall be designed, and their construction shall be accomplished, so that adequate and uninterrupted drainage of the JRA's right-of-way is maintained.
2. All pipes, ditches, and other structures carrying surface drainage on the JRA property and/or under the JRA track(s) shall be designed to carry the run-off from a one hundred (100) year storm. Computations and Plans submitted to the JRA for approval shall be prepared by a Professional Engineer and should indicate design, suitable topographic plan, and shall present the outline of the total drainage area.
3. If the drainage is to discharge into an existing drainage channel on the JRA's right-of-way and/or through a drainage structure under the JRA's track(s), the computations must include the hydraulic analysis of any existing ditch and/or structure.
4. When calculating the capacity of existing or proposed drainage structures, under the JRA's track(s), the headwater calculation at the structure shall not be greater than one (1).
5. Pipe(s) used to carry surface drainage on the JRA's right-of-way shall have a minimum diameter of 24 inches.
6. Detention ponds shall not be placed on any part of JRA's right-of-way. Also, the railroad embankment shall not be used as any part of a detention pond structure.
7. Formal approval of the proposed design, by the appropriate government agency having jurisdiction, shall be submitted with the drainage computations.

4.16 Pipelines on Bridges

1. No pipelines of any type may be installed on any bridge carrying JRA track(s) unless, in the sole discretion of the Engineer, the same is determined to be safe and advisable.
2. Overhead pipe bridges will only be considered over the JRA right-of-way when underground installation of the pipeline is not possible. The Applicant must show that no practicable alternative is available. Overhead pipe bridges will be permitted provided the following conditions are met:
 - a. The vertical clearance, distance from top of rail to closest component of structure, is shown and is a minimum of 23 feet, measured to a point 6 feet horizontally from centerline of track.
 - b. The support bents for the overhead structure are located off the JRA's right-of-way or a minimum clear distance of 20 feet from centerline track, whichever distance is greater.
 - c. Support bents within 25 feet of centerline track shall have pier protection in accordance with the current AREMA Chapter 8, Section 2.1.5.
 - d. Complete structure plans and design computations for the structure and foundations including core boring logs, sealed by a licensed Professional Engineer, are to be submitted with the application.
 - e. A fence (topped with barbed wire) or other measures are provided which will prevent access to the bridge by unauthorized personnel or vandals.
3. Pipelines carrying flammable substances or non-flammable substances, which by their nature might cause damage if escaping on or near railroad facilities or personnel, shall not be installed on bridges over JRA track(s). In special cases, where it is demonstrated to the JRA's satisfaction that such an installation is absolutely necessary and that no practicable alternative is available, the JRA may permit the installation, but only by special design approved by the JRA Engineer.
4. When permitted, pipelines on bridges over the JRA track(s) shall be so located as to minimize the possibility of damage from vehicles, railroad equipment, vandalism, and other external causes. They shall be encased in a casing pipe as directed by the JRA. (See Plate VII).

Section 5.0 Construction Requirements

5.1 Method of Installation

1. General Requirements
 - a. Bored, jacked, or tunneled installations shall have a bore hole essentially the same as the outside diameter of the pipe plus the thickness of the protective coating.

- b. The use of water or other liquids to facilitate casing emplacement and spoil removal is prohibited.
 - c. If, during installation, an obstruction is encountered which prevents installation of the pipe in accordance with these specifications, the JRA shall be notified immediately; the pipe shall be abandoned in place; and immediately filled with grout. Under such circumstances, before work may resume, a new installation procedure and revised plans must be submitted to, and approved by, the JRA and the Engineer.
2. Bore and Jack (Steel Pipe)
- a. This method consists of pushing the pipe into the earth with a boring auger rotating within the pipe to remove the spoil.
 - b. The boring operation shall be progressed on a 24-hour basis without stoppage (except for adding lengths of pipe) until the leading edge of the pipe has reached the receiving pit.
 - c. The front of the pipe shall be provided with mechanical arrangements or devices that will positively prevent the auger from leading the pipe so that no unsupported excavation is ahead of the pipe.
 - d. The auger and cutting head arrangement shall be removable from within the pipe in the event an obstruction is encountered.
 - e. The over-cut by the cutting head shall not exceed the outside diameter of the pipe by more than ½ inch. If voids should develop or if the bored hole diameter is greater than the outside diameter of the pipe (plus coating) by more than approximately 1 inch grouting (see the Construction Requirements – Grouting Section) or other methods approved by the Engineer, shall be employed to fill such voids.
 - f. The face of the cutting head shall be arranged to provide a reasonable obstruction to the free flow of soft or poor material.
 - g. Plans and description of the arrangement to be used shall be submitted to the JRA for approval and no work shall proceed until such approval is obtained.
 - h. Any method that employs simultaneous boring and jacking for pipes over 8 inches in diameter that does not have the above approved arrangement **shall not be permitted**. For pipe 8 inches and less in diameter, auguring or boring with this arrangement may be considered for use only as approved by the JRA.
3. Jacking (RCP and Steel Pipe)
- a. This method consists of pushing sections of pipe into position with jacks placed against a backstop and excavation performed by hand from within the jacking shield at the head of the pipe. Ordinarily, 36-inch pipe is the least size that should be used, since it is not practical to work within smaller diameter pipes.
 - b. Jacking shall be in accordance with the current AREMA Guidelines, Chapter 1, Section 4.13, “Earth Boring and Jacking Culvert Pipe Through Fills”, or such successor provision addressing the same subject matter. This operation shall be conducted without hand mining ahead of the pipe and without the use of any type of boring, auguring, or drilling equipment.
 - c. Bracing and backstops shall be so designed and jacks of sufficient rating used to that the jacking can be progressed on a 24-hour basis without stoppage (except for adding lengths of pipe) until the leading edge of the pipe has reached the receiving pit.

- d. When jacking reinforced concrete pipe, a jacking shield shall be fabricated as a special section of reinforced concrete pipe with a steel cutting edge, hood, breasting attachments, etc., cast into the pipe. The wall thickness and reinforcing shall be designed for the jacking stresses.
 - e. When jacking reinforced concrete pipe tapped for no smaller than 1-1/2 inch pipe, grout holes shall be cast into the pipe at manufacture. Three grout holes equally spaced around the circumference and 4 feet longitudinally shall be provided for greater than 54 inches (to 60 inches) and smaller. Four grout holes equally spaced around the circumference and 4 feet longitudinally shall be provided for 60 inches and larger.
 - f. Immediately upon completion of jacking operations, the installation shall be pressure grouted as per Construction Requirement – Grouting Section of these specifications.
4. Tunneling (tunnel liner plate)
- a. The method consists of placing rings of liner plate within the tail section of a tunneling shield or tunneling machine. A tunneling shield shall be used for all liner plate installations unless otherwise approved by the Engineer.
 - b. The shield shall be of steel construction, designed to support a railroad track loading as specified in the Design Requirements – Casing Pipe of these Specifications, in addition to the other loadings imposed. The advancing face shall be provided with a hood, extending no less than 20 inches beyond the face and extending around no less than the upper 240 degrees of the total circumference. It shall be of sufficient length to permit the installation of at least one complete ring of liner plates within the shield before it is advanced for the installation of the next ring of liner plates. The shield shall conform to and not exceed the outside dimensions of the liner plate tunnel being placed by more than 1 inch at any point on the periphery unless otherwise approved by the JRA Engineer.
 - c. The shield shall be adequately braced and provided with necessary appurtenances for completely bulkheading the face with horizontal breastboards, and arranged so that the excavation can be benched as may be necessary. Excavation shall not be advanced beyond the edge of the hood, except in rock.
 - d. Manufacturer's shop detail plans and manufacturer's computations showing the ability of the tunnel liner plates to resist jacking stresses shall be submitted to the Engineer for approval.
 - e. Unless otherwise approved by the Engineer, the tunneling shall be conducted continuously, on a 24-hour basis, until the tunnel liner extends at least beyond the theoretical railroad embankment line. (See Plate III)
 - f. At any interruption of the tunneling operation, the heading shall be completely bulkheaded and the JRA immediately informed of the interruption.
 - g. The liner plates shall have tapped grout holes for no smaller than 1-1/2 inch pipe, spaced at approximately 3 feet around the circumference of the tunnel liner and 4 feet longitudinally.
 - h. Grouting behind the liner plates shall be in accordance with the Construction Requirements – Grouting Section of these specifications.

5.2 Directional Boring / Horizontal Directional Drilling (Steel Pipe)

1. Method “A” – Directional Boring

- a. **Installations by this method are generally not acceptable.** Consideration will be given where the depth of cover is substantial, (greater than 15 feet), or the bore is in rock. Factors considered, within the discretion of the Engineer, will be track usage, pipe size, contents of pipeline, soil conditions, etc.
- b. This method consists of setting up specialized drilling equipment on existing grade (launching and receiving pits are not required) and boring a small diameter pilot hole on the desired vertical and horizontal alignment, using a mechanical cutting head with a high pressure fluid (bentonite slurry) to remove the cuttings. The drill string is advanced with the bentonite slurry pumped through the drill string to the cutting head and then forced back along the outside of the drill string, carrying the cutting back to the surface for removal. When the cutting head reaches the far side of the crossing, it is removed and a reamer is attached to the lead end of the drill string. The pipeline is attached to the reamer and the pilot hole is then back reamed while the pipe is pulled into place.
- c. The method is used to place pipeline under rivers, wetlands, and other obstructions that would be difficult to cross by conventional methods. The length of the bore is generally several hundred feet in length, with installations over a thousand feet possible.
- d. The following preliminary information shall be submitted with any request for consideration of this type of installation:
 - A site plan of the area;
 - A plan view and profile of the crossing;
 - An application form;
 - Several soil borings along the proposed pipeline route; and,
 - A construction procedure, including a general description of equipment to be used.

If the Engineer determines this method of installation is acceptable, final design plans and specifications shall be prepared and submitted for approval.

- e. The project specifications must require the contractor to submit, to the JRA Engineer for approval, a complete construction procedure of the proposed boring operation. Included with the submission shall be the manufacture’s catalog information describing the type of equipment to be used.

2. Method “B” – Jack Conduit

- a. This method is used to place small diameter conduit for electric lines and other utilities. This method consists of using hydraulic jacking equipment to push a solid steel rod under the railroad from a launching pit to a receiving pit. At the receiving pit, a cone shaped “expander” is attached to the end of the rod and the conduit (casing pipe) is attached to the expander. The rod, expander, and conduit are then pulled back from the launching pit until the full length of the conduit is in place.
- b. This method may be used to place steel conduit (casing pipe), up to and including 6 inches in diameter, under the railroad.
- c. The project specifications must require the contractor to submit, to the Engineer for approval, a complete construction procedure of the proposed boring operation.

Included with the submission shall be the manufacture's catalog information describing the type of equipment to be used.

5.3 Open Cut – Not a readily accepted practice

1. The Owner must specifically request open cut approval when making any application for occupancy. Where approved by the Engineer, all procedures shall be in compliance with AREMA Chapter 1, Section 5.5.1(b).
2. Installations beneath the track by open trench methods will be permitted only with the approval of the Engineer.
3. Installations by open cut shall not be permitted under mainline tracks, tracks carrying heavy tonnage or tracks carrying passenger trains. Also, open cut shall not be used within the limits of a highway/railroad grade crossing or its approaches, 25 feet either side of traveled way, where possible.
4. Rigid pipe (RCP, VCP, and PCCP) must be placed in a Class B bedding or better.
5. At locations where open cut is permitted, the trench is to be backfilled with crushed stone with a top size of the aggregate to be a maximum of 2 inches and to have no more than 5% passing the number 200 sieve. The gradation of the material is to be such that a dense stable mass is produced.
6. The backfill material shall be placed in loose 6 inch lifts and compacted to at least 95% of its maximum density with a moisture content that is no more than 1% greater than or 2% less than the optimum moisture as determined in accordance with current ASTM Designation D – 1557 (Modified Proctor). When the backfill material is within 3 feet of the subgrade elevation (the interface of the ballast and the subsoil) a compaction of at least 98% will be required. Compaction test results confirming the compliance must be provided to the Engineer.
7. All backfilled pipes laid either perpendicular or parallel to the tracks must be designed so that the backfill material will be positively drained. This may require the placement of lateral drains on pipes laid longitudinally to the track and the installation of stub perforated pipes at the edge of the slopes.
8. Unless otherwise agreed upon, all work involving rail, ties, and other track material will be performed by the railroad employees at the sole expense of the Owner, which shall be paid in advance by the Owner.

5.4 Grouting

1. For jacked and tunneled installations, a uniform mixture of 1:6 (cement:sand) cement grout shall be placed under pressure through the grout holes to fill any voids, which exist between the pipe or liner plate and the undisturbed earth.
2. Grouting shall start at the lowest hole in each grout panel and proceed upwards simultaneously on both sides of the pipe.
3. A threaded plug shall be installed in each grout hole as the grouting is completed at that hole.
4. A grouting plan shall be prepared by the Contractor and submitted for approval by the Engineer before proceeding with any jacking or tunneling installations.

5. When grouting tunnel liner plates, grouting shall be kept as close to the heading as possible, using grout stops behind the liner plates if necessary. Grouting shall proceed as approved by the Engineer, but in no event shall more than 6 lineal feet of tunnel be progressed beyond the grouting.

5.5 Soil Stabilization

1. Pressure grouting of the soils or freezing of the soils before jacking, boring, or tunneling may be required to stabilize the soils, control water, prevent loss of material, and prevent settlement or displacement of embankment. Grout shall be cement, chemical or other special injection material selected to accomplish the necessary stabilization.
2. The need for soil stabilization, the materials to be used, and the method of injection shall be prepared by a Licensed Professional Soils Engineer, or by an experienced and qualified company specializing in this work and submitted for approval to the JRA before the start of the work. Proof of experience and competency shall accompany the submission.

5.6 Dewatering

1. When water is known or expected to be encountered all plans and specifications must be submitted to the Engineer for approval before the construction process begins. Pumps of sufficient capacity to handle the flow shall be maintained at the site, provided the contractor has received approval from the JRA to operate them. Pumps in operation shall be constantly attended on a 24-hour basis until in the sole judgment of the Engineer the operation can be safely halted. When dewatering, a process for monitoring for any settlement of track or structures must be in place.
2. At the sole discretion of the Engineer an on-site inspector from or a representative of the railroad may be assigned during the dewatering operation. All such costs shall be the responsibility of the Owner.

5.7 Safety Requirements

1. All operations shall be conducted so as not to interfere with, interrupt, or endanger the operation of trains or damage, destroy, or endanger the integrity of railroad facilities. All work on or near JRA property shall be conducted in accordance with JRA and Railroad safety rules and regulations. The contractor shall secure JRA and Railroad safety rules and regulations and give written acknowledgement to the JRA and Railroad that they have been received, read, and understood by the contractor and the employees. **Specifically, all Applicant's or Owner's employees and agents, while on JRA property, shall be required to wear an orange hard hat, safety glasses with side shields, 6" lace up boots with a distinct heel, high visibility shirts with sleeves, and long pants. Additional personal protective equipment may be required for certain operations including abrasive cutting, use of torches, use of chainsaws, etc.** Operations will be subject to JRA inspection at any and all times.
2. All cranes, lifts, or other equipment that will be operated in the vicinity of the railroad's electrification and power transmission facilities shall be electrically grounded as directed by the JRA.

3. At all times when the work is being progressed, a field supervisor for the work with no less than twelve (12) months experience in the operation of the equipment being used shall be present. If boring equipment or similar machines are being used, the machine operator also shall have no less than twelve (12) months experience in the operation of the equipment being used.
4. Whenever equipment or personnel are working within the JRA right-of-way permission shall be required before entering property. If the proposed work limits are closer than fifteen (15) feet from the centerline of an adjacent track or if equipment is being utilized that has the capacity to reach within fifteen (15) feet from the centerline of an adjacent track, that track shall be considered as being obstructed. Insofar as possible, all operations shall be conducted no less than this distance. Operations closer than fifteen (15) feet from the centerline of a track shall be conducted only with the permission of, and as directed by, a duly qualified railroad employee present at the work site. All costs related to Railroad protection shall be passed on to the Applicant/Owner.
5. Crossing of tracks at grade by equipment and personnel is prohibited except by prior arrangement with, and as directed by, the JRA.

5.8 Blasting

1. Blasting shall not be permitted under or on JRA's right-of-way.

5.9 Temporary Track Supports

1. When the jacking, boring or tunneling method of installation is used and depending upon the size and location of the crossing, temporary track supports shall be installed at the direction of the JRA.
2. The Contractor shall be solely responsible for the design, construction and performance of the temporary structure.
3. All items of design, construction and performance shall be in accordance with the AREMA Manual and subject to the review and approval by the Engineer. Where conflicts exist, the most stringent specification shall be applied.
4. All assumptions used to design the temporary shoring system shall be listed in the structural design calculations.
5. Details of the temporary track support structures and structural members shall be designed to have design strengths at all sections at least equal to the required strengths calculated for the loads and forces in such combinations of loads and forces in AREMA Chapter 8 Part 2 Article 2.2.4b.
6. Temporary track support design shall determine E80 live load lateral and longitudinal pressures with the current time table speed impact factor.
7. Existing elevations of top of rail shall be shown on the shoring plans and monitored during the shoring operation with final elevation noted on record drawings upon completion of the pipeline installation.
8. The Owner's contractor shall supply the track supports with installation and removal performed by JRA employees or as directed by the Engineer.
9. The Owner shall reimburse the JRA for all costs associated with the design review, installation and removal of track supports.

5.10 Protection of Drainage Facilities

1. If, in the course of construction, it becomes necessary to block a ditch, pipe, or other drainage facility, temporary pipes, ditches, or other drainage facilities shall be installed to maintain adequate drainage, as approved by the Engineer. Upon completion of the work, the temporary facilities shall be removed and the permanent facilities restored.
2. Soil erosion methods shall be used to protect railroad ditches and other drainage facilities during construction on and adjacent to the JRA's right-of-way.

5.11 Support of Excavation Adjacent to Track

1. Launching and Receiving Pits
 - a. The location and dimensions of all pits or excavations shall be shown on the plans. The distance from centerline of adjacent track to face of pit or excavation shall be clearly labeled. Also, the elevation of the bottom of the pit or excavation must be shown on the profile.
 - b. The face of all pits shall be located a minimum of 25 feet from centerline of adjacent track, measured at right angles to the track, unless otherwise approved by the JRA Engineer.
 - c. If the bottom of the pit excavation intersects the theoretical railroad embankment line, (See Plate III) interlocking steel sheet piling, driven prior to excavation, must be used to protect the track stability. The use of trench boxes or similar devices is not acceptable in this area.
 - d. Design plans and computations for the pits, sealed by a licensed Professional Engineer, must be submitted by the Owner at time of application or by the contractor prior to start of construction. If the pit design is to be submitted by the contractor, the project specifications must require the contractor to obtain approval from the Engineer prior to beginning any work on or which may affect JRA property.
 - e. The sheeting shall be designed to support all lateral forces caused by the earth, railroad and other surcharge loads. See Design Requirements – Design Loads for railroad loading.
 - f. After construction and backfilling, all sheet piling within 10 feet of centerline track must be cut off 36 inches below final grade and left in place.
 - g. All excavated areas are to be illuminated (flashing warning lights not permitted), fenced, and otherwise protected as directed by the JRA.
2. Parallel Trenching and Other Excavation
 - a. When excavation for a pipeline or other structure will be within the theoretical railroad embankment line of an adjacent track (See Plate V), interlocking steel sheet piling will be required to protect the track.
 - b. The design and construction requirements for this construction shall be in accordance with the requirements of the Construction Requirements – Support of Excavation Adjacent to Track Section of these specifications.

5.12 Inspections and Testing

1. For pipelines carrying flammable or hazardous materials, ANSI Codes B 31.8 and B 31.4, or such successor provisions covering the same subject matter, current at time of constructing the pipeline, shall govern the inspection and testing of the facility on JRA property, except as follows:
 - a. One hundred percent of all field welds shall be inspected by radiographic examinations, and such field welds shall be inspected for 100 percent of the circumference.
 - b. The proof testing of the strength of carrier pipe shall be in accordance with the requirements of ANSI B 31.8 for Class Locations 2, 3, or 4, or ANSI B 31.4 as applicable, or such successor provisions covering the same subject matter.

5.13 Reimbursement of JRA Costs

1. All JRA costs associated with the pipe installation (inspection, flagging, track work, etc.) shall be reimbursed to the JRA by the Owner/Applicant. Reimbursement by the contractor is not acceptable.
2. Estimates for Railroad costs may be provided to the Owner prior to the commencement of any work on Railroad right-of-way. These funds shall be collected in advance of any work being done.

Publication Standard Sources

ANSI American National Standards Institute, Inc.
1430 Broadway
New York, NY 10018
(212) 642-4900

AREMA American Railway Engineering and Maintenance of Way Association
8201 Corporate Drive, Suite 1125
Landover, MD 20785-2230
(301) 459-3200

ASTM American Society for Testing and Materials
1916 Race Street

Philadelphia, PA 19103-1187
(215) 299-5585

AWWA American Water Works Association, Inc.
6666 West Quincy Avenue
Denver, CO 80235

The National Association of Corrosion Engineers
Houston, TX 77026

Note: If other than AREMA, ASTM, or AWWA specifications are referred to for design, materials, or workmanship on the plans and specifications for the work, then copies of the applicable sections of such other specifications referred to shall accompany the plans and specifications for the work.

Standard Plate Schematics to be attached here as an Appendix.